TB-25N

AIRTANKER FLIGHT EVALUATION

BY ARCADIA EQUIPMENT DEVELOPMENT CENTER
AND U.S. ARMY AVIATION TEST OFFICE
TMC / EDWARDS AFB

U.S. DEPARTMENT OF AGRICULTURE / FOREST SERVICE / WASHINGTON, D.C.

SUMMARY

The tested TB-25N airplane modified for use as an airtanker is not capable of accomplishing the airtanker mission with reasonable efficiency and safety. The airplane is not stressed to withstand the loads imposed on it by dropping liquid chemicals from the bomb-bay unless the load dropped is in increments of 3000 pounds or less. Also, airspeed must be kept within a narrow recommended range and only moderate simultaneous turbulence or maneuvering loads can be tolerated.

The stick force gradients in maneuvering flight at an aft C.G. are less than those specified in MIL-F-8785 (ASG) for Class II aircraft. With this exception, the stability and control characteristics of the test TB-25N are acceptable within the limits of the conducted tests.

No satisfactory escape system is provided.

TABLE OF CONTENTS

SPECIAL REPORT UNDER ED&T-1114

TB-25N AIR TANKER FLIGHT EVALUATION

February 1963

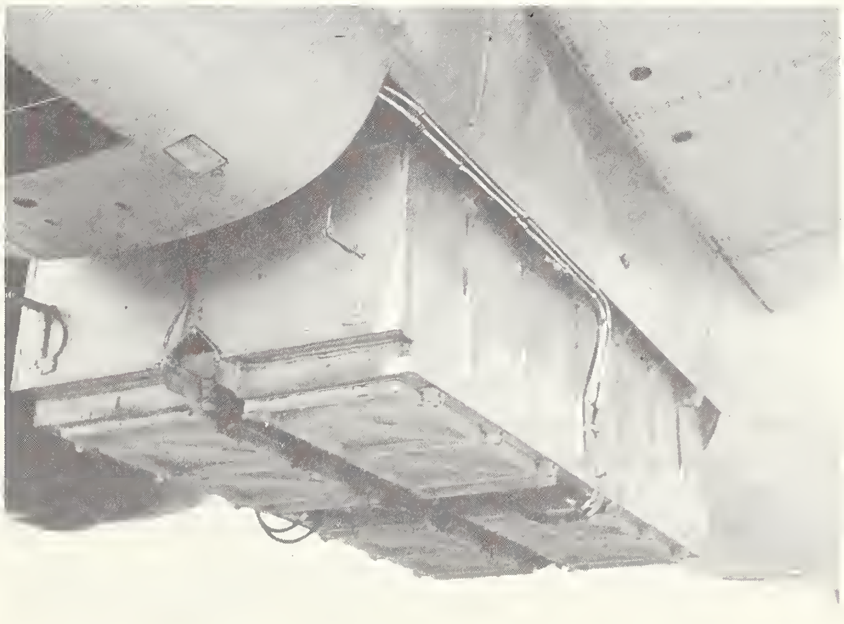
U.S. Army - Aviation Test Office, Edwards AFB
Flight Test Engineer....... Kenneth E. Jordan
Project Pilot.............. Emil E. Kluever

U.S. Forest Service - Arcadia Equipment Development Center
Project Coordinator .... Herbert J. Shields

INTRODUCTION

Limited performance, stability, and control tests were conducted in conjunction with a chemical drop survey on a North American TB-25N Monoplane, Serial Number N10564. The tests were conducted by the U.S. Army Transportation Materiel Command, Aviation Test Office at Edwards Air Force Base, California, for the U.S. Forest Service, Arcadia Equipment Development Center, Arcadia, California. A total of 37 hours and 5 minutes of flying time was required.

The TB-25N is a mid-wing monoplane with tricycle landing gear. Although normally powered by two R-2600-29A or R-2600-35 engines, for these tests the aircraft was powered by R-2600-20 engines. A 1240-gallon capacity tank was installed in the bomb-bay section to accommodate the liquid chemicals. The tank was nearly equally divided into forward and aft sections. The fire chemicals could be dropped from each section separately, or from both sections simultaneously, by means of cockpit controls.



TEST RESULTS

COCKPIT EVALUATION

Normal entrance to the aircraft is through the hatch just aft of the nose wheel and forward of the chemical tank in the bottom of the fuselage. The hatch swings down and a ladder extends automatically. The hatch opening does not allow clearance for pilots wearing back-pack parachutes to enter. Pilots must carry their parachutes into the cockpit and place them in the seats before putting them on. Horizontal and vertical clearance in the cockpit is inadequate for pilots wearing parachutes.

The only emergency in-flight exit is through the entrance hatch. By pulling the release on the ledge at the left side of the upper turret compartment, the pilot can jettison the hatch in flight. An emergency exit through this hatch would be difficult for a pilot wearing a parachute. If the aircraft were in uncontrollable flight and subject to large values of positive or negative accelerations, leaving the aircraft would be extremely difficult. The pilot and copilot positions should be supplied with ejection seats so that escape would be possible at low altitude.

After ditching or crash-landing, exit from the airplane could be accomplished through an overhead hatch in the pilot's compartment, or through a hatch in the nose section.

The seating arrangement consists of two side-by-side seats for pilot and copilot.

A period of familiarization is required to enable pilots to locate specific instruments on the panel. The altimeter, turn indicator, and rate-of-climb indicator are difficult to see, either through or over the control wheel. It would be desirable to relocate these instruments higher on the panel and grouped with other flight instruments. In addition, carburetor air-temperature indicators should be located adjacent to the manifold-pressure gages and tachometers, because engine power output is more easily estimated with these three instruments grouped together.

The control levers are not immediately identifiable by feel. Each lever, where only one is required, and each set, where two or more are required, should be equipped with knobs of specific shapes, such as cylinders, spheres, and cubes, for identification.

The cowl-flap levers at the lower left-hand corner of the vertical portion of the control pedestal are being used as door release handles for the chemical tank. Levers to control the cowl flaps have been installed behind and above the copilot's head. This is an undesirable location for these controls.

The propellers are feathered by depressing the appropriate feathering button on the control-pedestal switch panel. The feathering mechanism should be incorporated into the propeller control mechanism so that placing the propeller control lever in the most aft position would feather the propeller. The incorporation of the feathering sequence would also require a method of preventing inadvertent propeller feathering in flight.

The emergency release handles for the chemical tank ports should be moved from their position, over and behind the copilot's head, to a position ahead of the copilot where greater pull force could be applied more quickly in the event of an emergency.

> "The primary flight-control surfaces are conventionally operated by dual wheel and rudder pedal controls. Elevator stick forces are reduced by the action of a bungee installed in the control system. Although the effect of the bungee is not noticeable in flight, on the ground it will cause the control columns to fall forward if released with elevators neutral, or aft if released with elevators approximately 9 degrees up. Trim tabs on each control surface are mechanically controlled. The rudder and aileron trim wheels are on the cockpit floor between the pilot's seats; elevator trim is controlled by a wheel on the left side of the control pedestal .... All surface controls are locked by means of a controls lock on the floor forward of the pilots' control column. When the lock is folded and lying on the floor, the locking system is disengaged."[1]

ENGINE STARTING, TAXIING, AND GROUND HANDLING

The control-pedestal switch panel, located on the top of the pedestal forward of the throttles, contains all the switches necessary for engine starting. The procedure for engine starting is as follows:

1. The throttles are opened slightly.
2. The master ignition and booster pump are switched "on".
3. The starter is energized.
4. While the starter is energizing, the primer is used for several "shots" to fill the primer lines.
5. The pilot must operate the "engage" switch and primer while continuing to hold the "energize" switch.
6. After two revolutions of the propellers (or six blades), the ignition switch is turned to "both."
7. When the engine is running, the "energize" and "engage" switches are released.
8. The primer is held until the mixture control is moved to "full rich." A more desirable arrangement would be to have the "energize" and "engage" mechanisms combined so that only two switches are operated simultaneously--the primer and starter.

Taxiing is easily accomplished with rudder and thrust control, if the directional changes are led with sufficient power and adequate rudder displacement. Control

---

[1] Taken from "Flight Operating Instructions," AN01-60GE-1.

of the nose-wheel position during parking requires light and smooth brake applications. At the high gross weights, care should be taken at low speeds to prevent excessive loads on the landing gear struts. The brake forces and rudder effectiveness are adequate for all ground handling. The field of vision is adequate for taxiing and ground handling.

TAKE-OFF AND INITIAL CLIMB[1]

Prior to take-off, the pilot should follow the normal procedures to determine that all engines are operating within the specified limits. He should also make certain that the airplane controls are free, the instruments are set and within desired range, and the fuel and induction systems are properly managed. The trim is set to neutral for take-off. For a normal take-off, wing flaps should be set to the 15-degrees down position.

The throttles should be advanced to increase manifold pressure to 30 inches Hg before brake release. At this time, a rough check of engine operation should be made. The take-off roll is begun with brake release and a smooth application of power up to take-off power. After brake release, directional control is maintained with thrust and rudder deflection. The rudders become effective at about 30 knots indicated airspeed. Except in an emergency, brakes should not be utilized for directional control during take-off. The aircraft should be rotated to a slightly nose-high attitude at about 70 knots. The aircraft will lift off between 90 and 100 knots indicated airspeed.

The throttles should be reduced to normal rated power (41 inches Hg, 2400 rpm) after the gear and flaps have been retracted and the aircraft has attained a safe single-engine speed of 98 knots indicated airspeed. Acceleration should then be continued up to the recommended climb speed.

The nose of the airplane limits the field of vision straight ahead during climb. The engine nacelle limits the field of vision laterally between the 4 and 8 o'clock positions.

CLIMB PERFORMANCE

Saw-tooth climb tests were conducted to determine the climb performance of the TB-25N. The tests were conducted at pressure altitudes of 5, 000 and 10, 000 feet.

A comparison of maximum climb rates for the two power conditions and the heavy and light gross weights is presented in the table on page 5.

Using saw-tooth climb data, two continuous climbs were calculated. The calculated continuous climbs at gross weights of 22, 820 and 32, 560 pounds, respectively, indicate normal decreases in rate of climb with altitude (figs. 3 and 4).[2]

Data in figures 3 and 4 show that a climb begun at 7500 feet, at a heavy gross weight and normal rated power, would require 3. 8 nautical miles to clear a 1000-foot object. The continuous climb data for the light-weight climb at normal

---

[1] No take-off performance data were recorded during these tests.
[2] Figures 3 to 18 will be found in the Appendix.

STANDARD-DAY CLIMB PERFORMANCE

Altitude ft	True Airspeed knots	Calibrated Airspeed knots	Rate of Climb ft/min	Handbook Rate of Climb ft/min
Two Engines--Normal Rated Power * -- Gross Weight = 32, 560 Pounds				
5, 000	136	128	1130	1100
10, 000	143	135	380	800
Two Engines--Take-Off Power ** -- Gross Weight = 32, 560 Pounds				
5, 000	132	125	1250	Not available
10, 000	140	132	470	Not available
Two Engines--Normal Rated Power--Gross Weight = 22, 820 Pounds				
5, 000	142	134	2080	2250
10, 000	150	142	1710	1150
Two Engines--Take-Off Power--Gross Weight = 22, 820 Pounds				
5, 000	134	127	2310	Not available
10, 000	141	133	1950	Not available

rated power show that, beginning at 7500 feet, 1.4 nautical miles would be required to climb 1000 feet. By using take-off power, these distances could be cut down about 9 per cent.

The limited field of vision over the nose in a climb is especially undesirable when the aircraft is operated in mountainous terrain.

LIQUID CHEMICAL DROP TESTS

Operational Criteria. The most important factor to be considered is the load factor encountered during the drop. The load factor is defined as the acceleration of the aircraft at the center of gravity in a direction normal to the longitudinal axis of the aircraft. The load factor is commonly referred to as "Center of Gravity Normal Acceleration."

The design limit load factor of an airplane is that load which the aircraft structure should be capable of withstanding without yielding; i.e., receiving a permanent deformation. The ultimate load factor is the maximum load an aircraft structure can sustain without structural failure.

None of the preceding factors can be guaranteed in all aircraft structures. Throughout the years an aircraft remains in service, it is subjected to conditions which weaken the structure: corrosion, structural modifications, turbulence, hard landings, vibrations and general hard usage. These are variables that cannot be accounted for in the original determination of the structural strength. No guarantee exists that the design limit load factor, margin of safety, or ultimate load factor have not been compromised or changed.

---

* Normal rated power; Eng rpm = 2, 400, MAP = 41 in. Hg.
** Take-off power; Eng rpm = 2, 600, MAP = 43.5 in. Hg.

Another factor to be considered is the manner in which the aircraft is loaded. An airplane wing is subjected to larger bending moments when the fuselage is heavily loaded than when part of the load is distributed along the span of the wing. The combination of wing and fuselage load, and the resulting structural strains, determine the limit load factor.

Experience has shown that it is difficult to accomplish any mission under normal conditions without being subjected to load factors of at least 2.0 as a result of turbulence or maneuvering. Many chemical drops in fire-fighting are made with the aircraft in a rolling pull-out maneuver, in moderate, to very heavy turbulence. Therefore, a margin of one is considered necessary between the load factor encountered in a drop under ideal conditions and the design limit load factor.

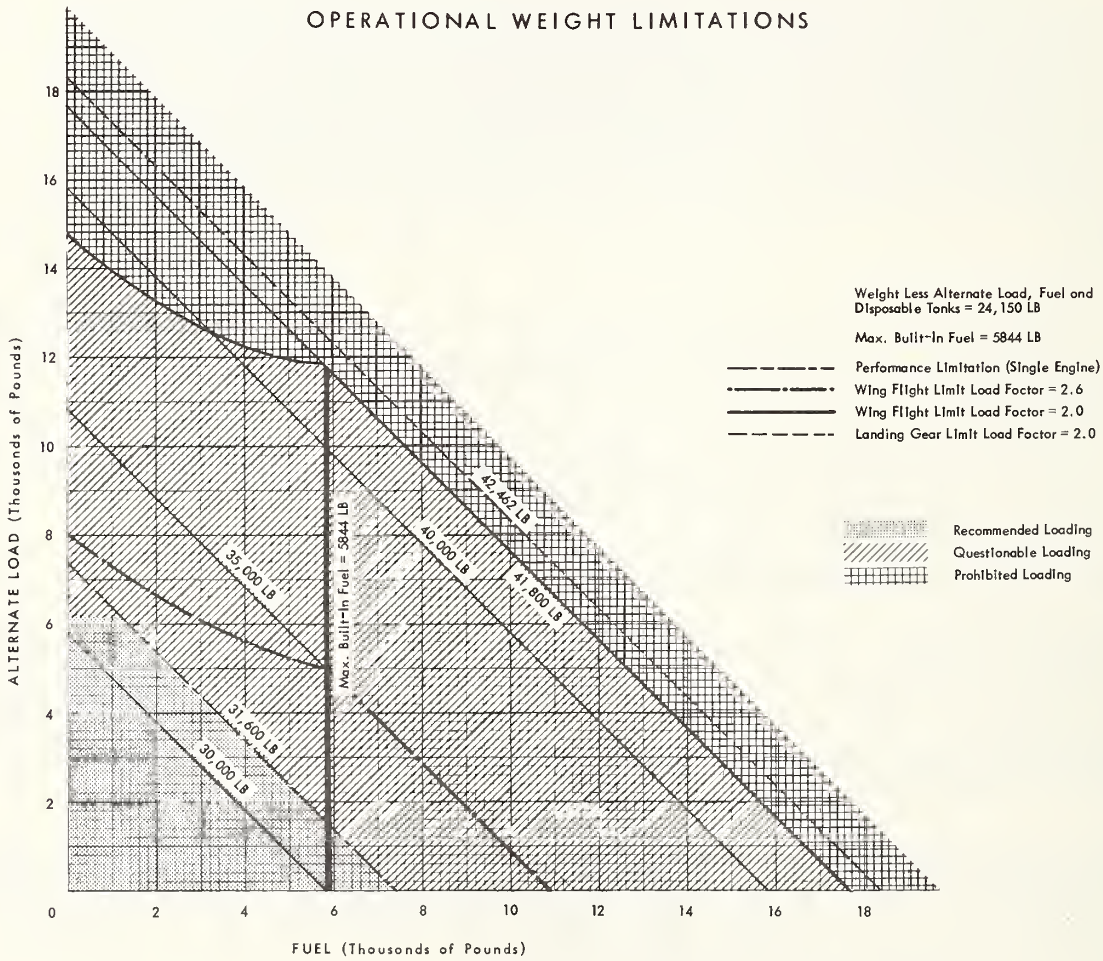


FIGURE NO. 1

Test Criteria. To have a basis for determining flight test safety limits, it was necessary to establish a limit load factor for the test aircraft. The Operational Weight Limitations (fig. 1) is for a TB-25J with a basic weight of 24,150 pounds. The basic weight of the test aircraft was 19,873 pounds. This difference allows 4277 pounds in the fuselage before entering the chart. The test airplane using 10,000 pounds as an alternate load and 3600 pounds as a fuel load would be operating with a limit load factor of 2.6 g's. (Alternate load 10,000 - 4277 = 5723

pounds and 3600 pounds fuel load). This liberal limit load factor cannot be applied to all TB-25N airtankers as there are too many unknowns which are characteristic of the individual aircraft.

Test Description. All but four drop tests were accomplished at a pressure altitude of 7500 feet in smooth air. Four drops were conducted at 75 feet above the local terrain (approximately 2300 feet altitude) at Grey Butte airport. These included the borate drops and one 600-gallon water drop.

The copilot operated the two tank-door handles, located in the lower right corner on the vertical section of the control pedestal, which activated the tank - door hydraulic system and opened the doors. To minimize the severity of the maneuver, the pilot anticipated the drop with nose-down control.

Drop Test Results. The test results show that airspeed variation has the most pronounced effect on load factors that result from chemical drops. Two drop summaries (figs. 5 and 6) show the effect of airspeed during drops on:

1. Maximum center of gravity normal acceleration.

2. Elevator position.

3. Longitudinal stick force.

4. Pitch rate.

5. Pitch angle.

6. Angle of attack.

7. Time to accelerate to maximum center of gravity normal acceleration.

Configuration. The configurations referred to in this report are: "clean," "landing," and "drop." The "clean" configuration refers to a streamlined airplane; that is, landing gear and wing flaps are up. In the "landing" configuration, the landing gear is down and the flaps are down 45 degrees. In the "drop" configuration, the landing gear is up and the flaps are down 15 degrees.

These graphs include data accumulated during clean-configuration drops as well as data of 15-degree flap-configuration drops. For these tests the tank was loaded with 300 gallons in the forward section and 300 gallons in the aft section. The aft load was released first, and sufficient time was allowed before the forward section was dropped for the airplane to stabilize on trim conditions. An attempt was made to minimize the severity of the maneuver by leading the drops with an elevator control force input.

Figure 5 shows the 15-degree flap-configuration drops. It can be seen that the maximum center of gravity normal acceleration increases gradually with airspeed from 1.6 for the aft-tank, and 1.7 for the forward tank, at 120 knots CAS (calibrated airspeed) to 1.7 and 1.8, respectively, at 146 knots. As airspeed was increased above 146 knots the tests produced a sharp rise in CG normal acceleration.

Clean configuration drops are summarized in figure 6. The maximum CG normal acceleration is 1.65 for the aft and 1.8 for the forward load drops at 120 knots CAS. As the airspeed increases to 141 knots CAS the acceleration also increases to 1.8 for the aft and 2.0 for the forward load drops. Dropping under any combination or sequence at speeds over 145 knots CAS causes the acceleration to increase rapidly to the design limit load factor.

It will be noted, by comparison, that the clean drops are slightly more severe than when using 15-degree flaps. Figure 7, Drop Configuration Summary, confirms this fact. The use of more than 15 degrees of flap is not recommended, however, since unknown torsional stresses are placed on the wing structure when the aircraft is rotated around its lateral axis [1] with the flaps down.

Figure 8 shows how an increase in quantity of material gradually increases the load factor produced by the drop. The effects of dropping a more viscous solution, such as borate, decreases the load factor at lighter loads; however, no effect is noticed when a heavier load (9400 pounds) is dropped.

Time-history traces that illustrate the four more interesting drops performed are included in figures 9 through 12. (A drop of 600 gallons of water dropped simultaneously at about 122 knots CAS, with 15 degrees of flaps and elevator control lead, is referred to as a "normal drop.")

Figure 9 was traced during a normal drop with the exception that a forward stick input was applied, and then released during the time the load factors began to build-up, thus simulating a drop with no stick force lead. This drop was more severe than the normal 600-gallon drops and substantiates the desirability of leading with forward stick in order to minimize load factors.

Figure 10 represents a 1000-gallon drop of borate. Since borate is more viscous than water, more time is required for it to drop out of the tanks into the airstream. As a result, approximately one-half second more time is required for the aircraft to reach its condition of maximum CG normal acceleration.

The stick fixed drop in figure 11 illustrates a 400-gallon drop with no control input until 1.3 seconds after the acceleration force begins to increase. The pitch rate during this drop increased rapidly to its peak of 25 degrees per second. As can be seen, the control forces required to hold the nose down are high, and in some cases beyond the 150-pound recording device limit.

Time Delay. Referring again to figure 5, when 300 gallons were dropped from the forward and aft tanks, the results were reduced 0.6 and 0.7 g, respectively, when compared with a normal 600-gallon drop. A further test was conducted with 0.5-second delay between each tank. As a result, the CG acceleration was reduced to 1.5 g's, versus 2.2 g's, for the simultaneous drop. Figure 12 is a time-history illustrating this technique. Figure 13 apparently shows the 0.5-second delay as an optimum delay. It also indicates that the effect with borate is less. Additional tests which would allow greater time delays would be needed to determine the optimum time separation.

---

[1] Lateral Axis: The reference axis of an airplane running through the CG from wing tip to wing tip.

Low Altitude Drops. The four low altitude drops at Grey Butte airport were covered photographically with a Fairchild Flight Analyzer. Two drops of 300 gallons of borate were made (150 gallons in each tank) and as a result an altitude of 50 feet was gained immediately on each test. When using water under the same conditions, 60 feet was gained. With 500 gallons of borate simultaneously dropped (250 gallons each tank), an increase of 90 feet was recorded.

DISCUSSION

Maneuvers. Drops should be planned so that maneuvering is not necessary during the load release period. A rolling pull-out maneuver imposes the most extreme loads on an aircraft structure. It is highly probable that under conditions of heavy turbulence, when dropping over 3000 pounds (fig. 8) and in a rolling pull-out, a TB-25N could easily exceed the design limit load factor and incur structural damage as a result. Further, it is likely that the limit load factor would be exceeded if:

1. The airspeed were allowed to build up to 150 knots calibrated airspeed (figs. 5 and 6).

2. Turbulence increased.

3. A rolling pull-out maneuver was tightened.

In addition, it was assumed that the design limit load factor had never been exceeded, that is, the aircraft had never been deformed. At this stage in the life of the airplane, it was not possible to accurately determine the number of times the design limit load factor could be exceeded without a structural failure.

Load Effect. Load factors can be reduced by decreasing the amount of chemical dropped. Reduction of the chemical load released at one time to less than 3000 pounds would be required to provide an adequate margin of at least one g.

Airspeed. Airspeed during a drop should be kept as low as possible and at the same time above a safe single-engine minimum control speed of 105 knots CAS. At no time during a drop should airspeed be allowed to increase beyond 145 knots CAS. Figure 2 [1] recommends certain airspeeds for penetrating turbulent air. It is interesting to note that the recommended drop regime (105 to 145 knots CAS) determined from the tests falls in the caution area for penetrating average turbulence. Operating in areas of high gusts at airspeeds within the chemical drop range would subject the aircraft to dangerous loads.

Flaps. Fifteen-degree flaps should be used to minimize load factors without inducing excessive wing structure stress.

Time Delay. If further investigation proves that the time-delay drop technique is also applicable to the more viscous chemicals, it should be incorporated in the drop procedures.

---

[1] Taken from "Flight Operating Instructions", AN01-60GE-1.

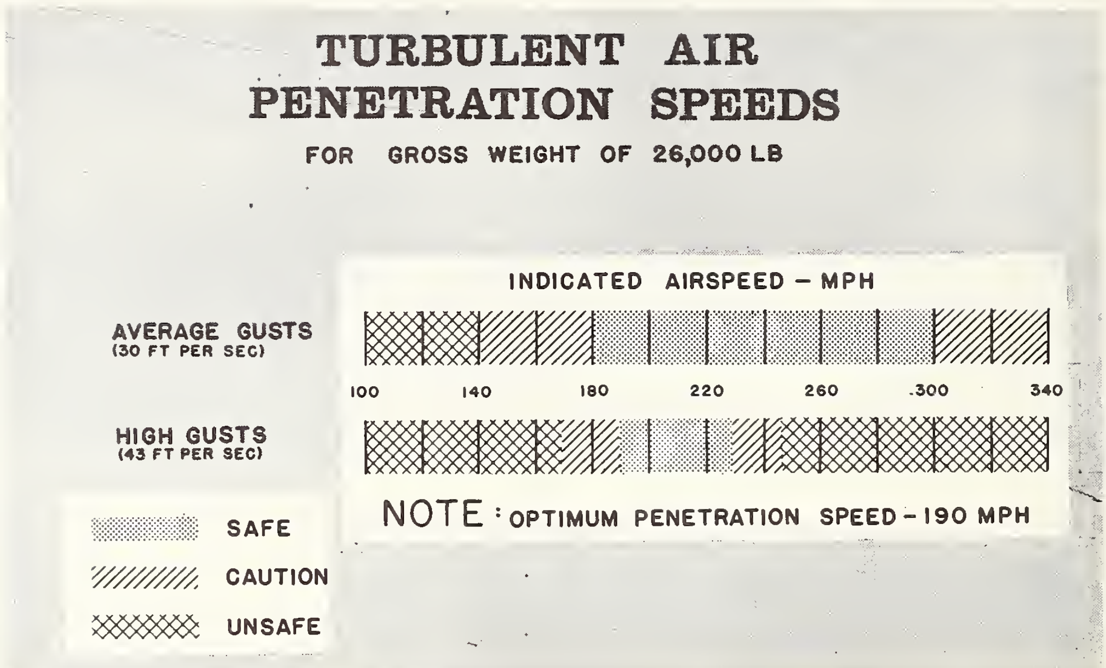


FIGURE NO. 2

STATIC LONGITUDINAL STABILITY

Tests were conducted with the aircraft in a "clean," "landing," and "drop" configuration. The static longitudinal stability is positive in all cases and within the requirements of MIL-F-8785 (ASG). The airplane has positive stability just before a drop with the aircraft at a heavy weight (33, 930 pounds) with 15 degrees of flap. At a condition just after a drop, before the flaps are retracted, the stability remains positive. Lowering the flaps has little effect on the stability. The static stability remains positive in the "landing" configuration (i.e., with 15-degree flaps and landing gear down). High airspeed has little effect upon the stability of the aircraft.

The static Longitudinal Stability Summary (fig. 14) indicates the positiveness of the stability in the three configurations.

No tests were conducted with the aircraft center of gravity located at the forward and aft limits.

STATIC LATERAL-DIRECTIONAL STABILITY

The variation of aileron angle with sideslip [1] indicates that the apparent positive dihedral effect is nearly independent of airspeed (fig. 15). The apparent dihedral effect is slightly increased by lowering the flaps to 15 degrees and opening the chemical tank doors.

---

[1] Apparent dihedral effectiveness parameter.

The same summary shows the variation of rudder angle with sideslip.[1] This indicates that the apparent directional stability is decreased with airspeed. The apparent directional stability is decreased with flaps down 15 degrees and chemical tank doors open.

No unsatisfactory static lateral-directional stability conditions are created with the flaps down 15 degrees and chemical tank doors open.

The static lateral-directional stability of the airplane meets the requirements of MIL-F-8785 (ASG).

DYNAMIC STABILITY

Dynamic perturbations induced by the elevator are very nearly deadbeat (immediately damped) with the controls fixed for both forward and aft pulses of the control column.

The dynamic lateral-directional damping is positive and essentially deadbeat for left and right directional pulses and left and right sideslips.

MANEUVERING FLIGHT CHARACTERISTICS

Accelerating turns were conducted with the aircraft in the "clean" configuration and varying center of gravity positions. They were 235 inches, 241 inches, and 246 inches behind the nose for forward, mid, and aft center of gravity positions, respectively. The forward and aft center of gravity limits were 235.9 and 247.5 inches, respectively. The trim airspeed for the test was 126 knots calibrated airspeed. Figure 16 shows that little stick force is required to increase the normal acceleration with the aircraft center of gravity located near its aft limit. When the normal acceleration of the aircraft in the aft center of gravity condition exceeds 1.55, the stick force required to increase the acceleration is less than that specified in MIL-F-8785 (ASG). Stick-force gradients are below minimum for normal flight where less than 1.4-g accelerations are encountered and the center of gravity is located other than near the forward limit. The elevator position gradients with increasing normal accelerations are positive, although low. Figure 17 illustrates that the stick-force gradient is below that of MIL-F-8785 (ASG) for 1.2-g flight when the center of gravity is located aft of the 241-inch position.

MIL-F-8785 (ASG) requires that the stick-fixed and stick-free maneuver points be located behind the aft center of gravity limit. It is therefore recommended that the aft center of gravity be moved forward 1.5 inches to a new limit of 246.0 inches.

STALLS

The TB-25N stall characteristics are satisfactory in all the cases tested. All stalls conducted were followed by an easily controllable break during which the aircraft nose fell through straight ahead. During the recovery, the controls remained effective.

---

[1] Apparent directional stability parameter.

Stalls were accomplished with the aircraft in a clean, 15-degree flaps, and 15-degree flaps plus landing gear configuration. These stalls were conducted with the center of gravity between 236.5 inches (forward limit 235.9 inches) and 239.4 inches (aft limit 247.5 inches) and the gross weights between 29,270 pounds and 29,400 pounds, respectively. Four stall tests were preceded by pre-stall buffet regions of 2 to 6 seconds duration. These stalls were conducted at gross weights ranging from 32,100 pounds to 32,250 pounds and center of gravity locations from 245.5 to 245.7 inches. It is interesting to note that the lighter weight stalls with the centers of gravity located near the forward limit of 235.9 inches are not preceded by pre-stall buffet. The stalls conducted at the heavier weights with the aft center of gravity near 247.5 inches, however, are preceded by pre-stall buffet.

The following table summarizes the stall speeds for the tested configurations and conditions.

Calibrated Trim Speed knots	Altitude ft	Gross Weight lb	Center of Gravity Position inches	Configuration	Power	Indicated Stall Speed knots
95	7500	29,280	237.9	15° Flaps	PFLF*	82
94	7500	29,270	236.5	15° Flaps & Gear	PFLF	80
92	7500	29,400	239.4	Clean	PFLF	87
104	7500	32,100	245.5	Clean	Power off	96
95	7500	32,220	245.7	15° Flaps	PFLF	82
97	7500	32,250	245.7	Clean	PFLF	90
104	7500	32,200	245.5	15° Flaps	Power off	92

APPROACH AND LANDING

The downwind leg for a normal power-approach is entered at 145 knots indicated airspeed. The landing gear and 15 degrees of flaps are extended when the aircraft is adjacent to the desired touchdown point on the runway. A descending turn is made onto the base leg and the airspeed is allowed to decrease to 130 to 140 knots indicated airspeed. Full flaps are lowered after the turn onto the final leg and an approach speed between 105 and 115 knots indicated airspeed is held during the final approach. The aircraft nose is aimed for a point just short of the approach end of the runway, and this perspective is held to a point just short of the runway. As this point is reached, power is reduced slowly and smoothly until a landing attitude is attained. The landing attitude is held and the aircraft is touched down with the main wheels first, allowing the nose to settle gently before the elevator effectiveness is lost. The center of gravity of the airplane is ahead of the main gear; therefore, the nose will fall through rapidly if the aircraft is stalled at touchdown. The touchdown speed should be slightly higher than the stall speed.

---

* PFLF: Power for level flight at 2,400 rpm.

Directional control during the landing roll can be maintained with the rudders. Because of their tendency to overheat, the brakes should be used as little as possible.

AIRSPEED CALIBRATION

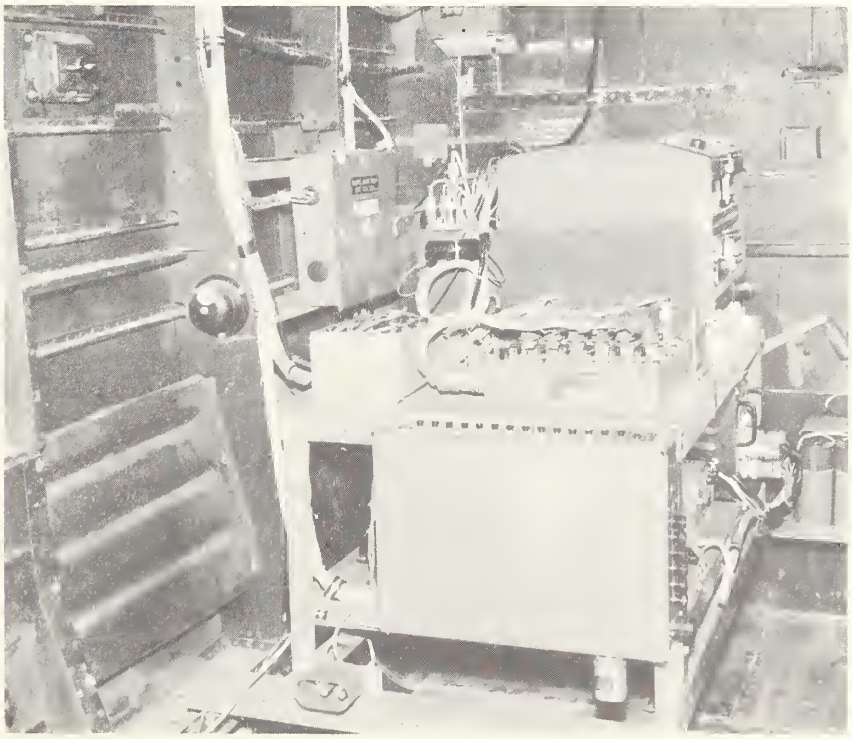
The aircraft was equipped with a test nose boom airspeed system and a pitot head. The test and standard airspeed systems were calibrated using the ground speed course method. The results of the airspeed calibration are presented in Figure 18.

CONTROL SYSTEM FRICTION AND BREAK-OUT FORCE

The elevator and aileron break-out forces are beyond the limits of MIL-F-8785 (ASG), although these forces are not objectionable. The rudder control break-out force is marginal. The break-out force and friction data indicate that the control system friction is quite large in most instances. The following table contains a summary of break-out forces and the specified limits.

MAXIMUM ALLOWABLE BREAK-OUT FORCES
(INCLUDING FRICTION) POUNDS

Control	MIL-F-8785 (ASG)	Test Aircraft
Elevator	7	8
Aileron	6	7.5
Rudder	14	14



CONCLUSIONS

Since no performance or maneuverability requirements for fire-fighting aircraft have been estabilished, conclusions could not be drawn concerning performance or maneuverability characteristics during this evaluation.

The field of vision of the TB-25N during climbs is limited over the nose of the aircraft.

Test results show that the TB-25N is unsatisfactory for use as a airtanker because it cannot accomplish a mission with any degree of safety if normal techniques are used while dropping a load of over 3000 pounds of chemical.

The drop mission is subjected to conflicting areas of safety by the cumulative effects of: (a) g-loads from the drop itself, (b) g-loads encountered from maneuvering, and (c) g-loads from turbulence. All of these are additive. Furthermore, recommended drop speeds fall within the caution area for penetrating average turbulence. In addition, past history of number of cycles to which airframe has been subjected to severe loads is unknown and limits predicted service life.

Airspeed must be held below 145 knots calibrated airspeed and above the safe, single-engine, minimum control speed of 105 knots calibrated airspeed. The unknown effect on the wing structure during the severe nose-up rotation during drops precludes lowering wing flaps beyond 15 degrees.

The TB-25N in its modified configuration as an airtanker meets the stability requirements of MIL-F-8785 (ASG) with the exception of the aft center of gravity stick-force gradients. To meet the aft center of gravity stick-force gradients, it is necessary to fly the aircraft with the center of gravity located forward of the mid-center of gravity position. The dynamic stability of the aircraft is deadbeat (immediately damped) in all the cases tested.

The stall and recovery characteristics of the TB-25N are satisfactory and easily controllable.

The escape provisions are inadequate.

Based on the above and other deficiencies and limitations, the tested TB-25N airplane modified for use as an airtanker is not capable of accomplishing the airtanker mission with reasonable efficiency and safety.

RECOMMENDATIONS

1. The following limitations be imposed if the TB-25N is considered for use as an airtanker:

    a. Airspeed held below 145 knots calibrated airspeed during any chemical drop. (Page 9)

    b. Wing flaps not extended beyond 15 degrees for chemical drops. (Page 9)

    c. The weight of the load released at one time not exceed 3000 pounds. (Page 9)

2. The aircraft center of gravity should be located near the forward limit to meet the stick-force gradient requirements of MIL-F-8785 (ASG). (Page 11)

3. A satisfactory low-altitude escape system should be provided for the authorized crew. (Page 2)

4. The cowl-flap handles should be moved to a more convenient location on the control pedestal. (Page 2)

5. The chemical tank emergency release handles should be relocated forward of the copilot. (Page 3)

6. The altimeter, turn indicator, and rate-of-climb indicator should be relocated to positions higher on the instrument panel and grouped with the other flight instruments. (Page 2)

APPENDIX

AIRCRAFT FLIGHT LIMITS

Limit-Load Factors at 34, 400 lb, 600 gal Fuel are + 2. 6 g's to -0. 5 g's.

MAXIMUM AIRSPEED

Landing gear Extension (normal system)	148 knots
Landing gear Extension (emergency system)	130 knots
With gear extended and flaps up	174 knots
Wing flap extension (normal system)	148 knots
Wing flap extension (emergency system)	130 knots
Turbulent Air	213 knots

POWER PLANT

The airplane is powered by two Wright Cyclone (Model R-2600-20) 14-cylinder, radial, air-cooled engines equipped with Holley carburetors and integral two-speed superchargers. The engines drive three-blade, full feathering, Hamilton standard hydromatic propellers.

ENGINE LIMITATIONS

Power (Time Limit)	RPM	MAP* in. Hg	Max Cylinder Head Temp. -°C
Take-off (5 min)	2600	43.5	248
Normal Rated	2400	41	232

* Manifold absolute pressure

WEIGHT AND BALANCE

The aircraft was weighed in a closed hanger in the level-flight attitude with oil and trapped fuel. The results of this weighing are as follows:

Basic Wt = Empty Wt + Trapped Fuel + Oil Supply

Empty Wt + Trapped	19869 lb at 237. 36 in.
Oil Supply (70 gal)	525 lb at 246. 00 in.
Basic Wt	20394 lb at 237. 58 in.

A second weighing was made with the fuel load used during the tests. These results are as follows:

Basic Wt	20394 lb at 237. 58 in.
150 gal ea rear main	
125 gal ea front main	
57 gal l. h. aux tank	
25 gal r. h. aux tank	
632 gal total fuel	3710 lb
Test Wt	24108 lb at 241. 37 in.

A third weighing was made with the fuel load used during tests plus a full load of water in the chemical tank. The result is as follows:

Test Wt + full load 34189 lb at 247. 91 in. of Water at 8. 34 lb/gal.

FIGURE NO. 3
CLIMB PERFORMANCE
TB-25N s/n 10564
NORMAL RATED POWER

ENGINES: TWO WRIGHT CYC. R-2600-20
CLIMB GROSS WT: 22820 LB.
COWL FLAPS: OPEN
SUPERCHARGER: LOW
PROPS: HAMILTON STD, 3 BLADE, HUB: 23E50

MIXTURE: RICH
RPM: 2400
CARB AIR: COLD

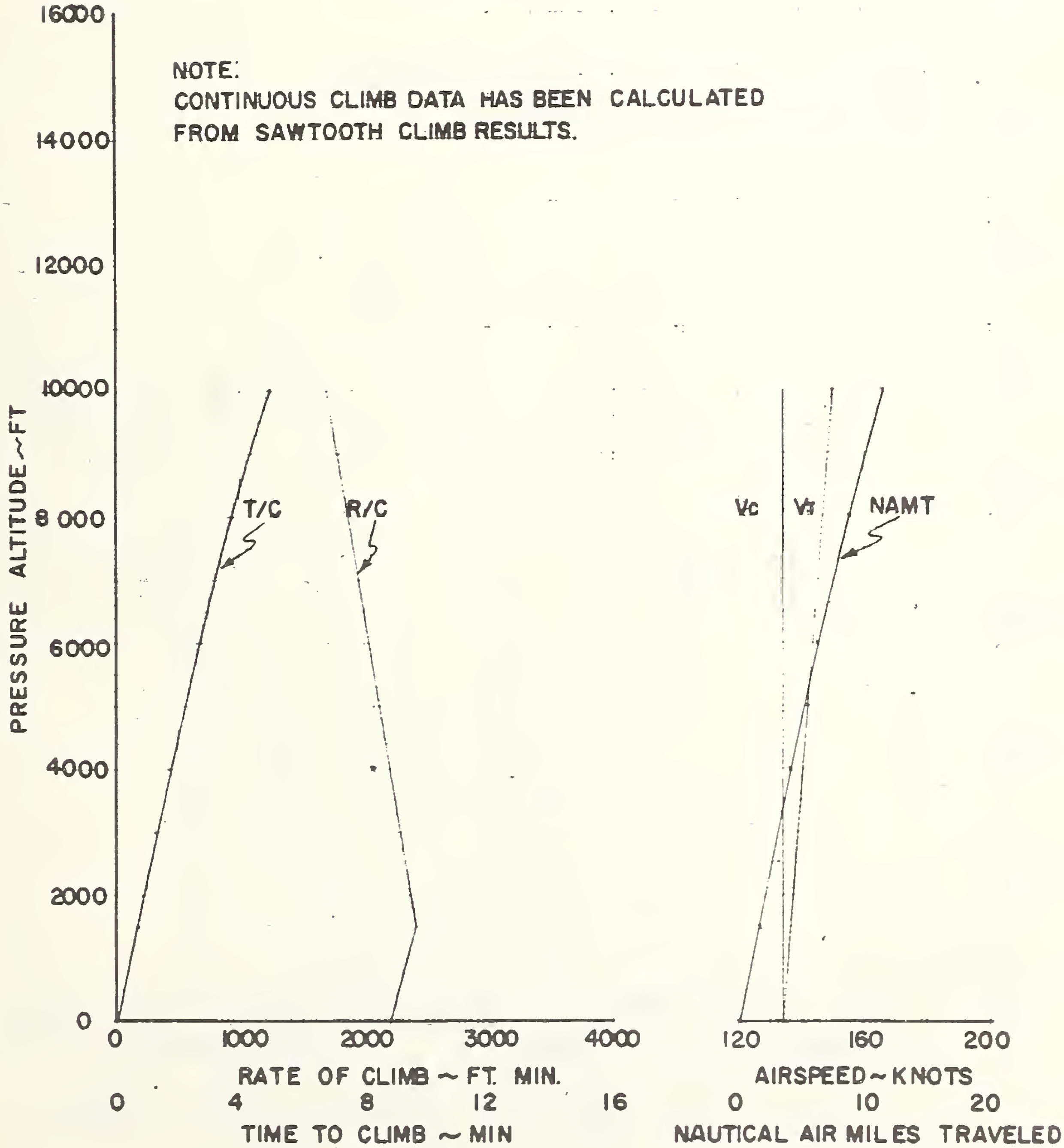


FIGURE NO. 4
CLIMB PERFORMANCE
TB-25N s/n 10564
NORMAL RATED POWER

ENGINES: TWO WRIGHT CYC. R-2600-20
CLIMB GROSS WT: 32560 LB
COWL FLAPS: OPEN
SUPERCHARGER: LOW
PROPS: HAMILTON STD., 3 BLADE, HUB: 23E50

MIXTURE: RICH
RPM: 2400
CARB AIR: COLD

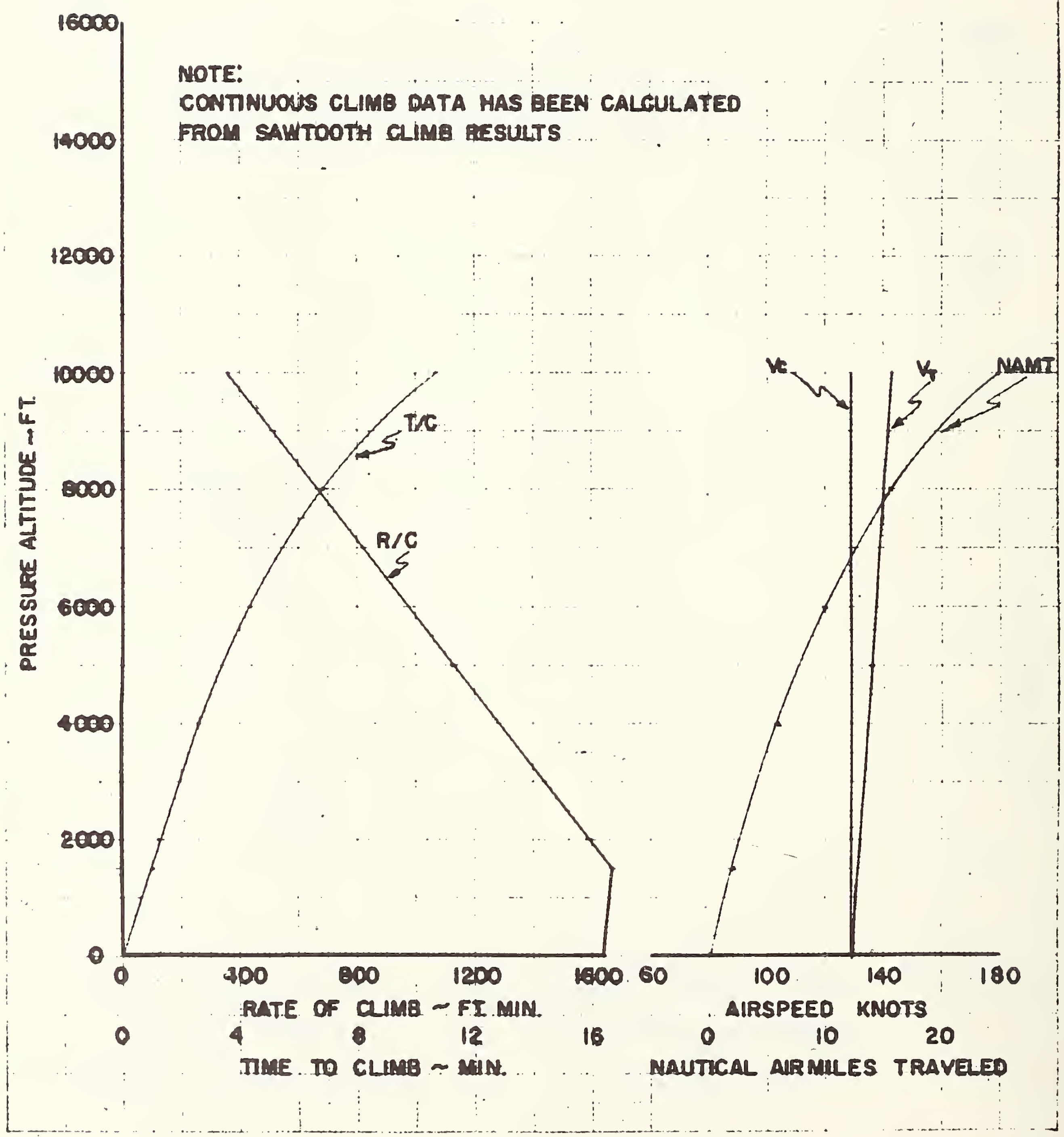


FIGURE NO.4(CONTINUED)

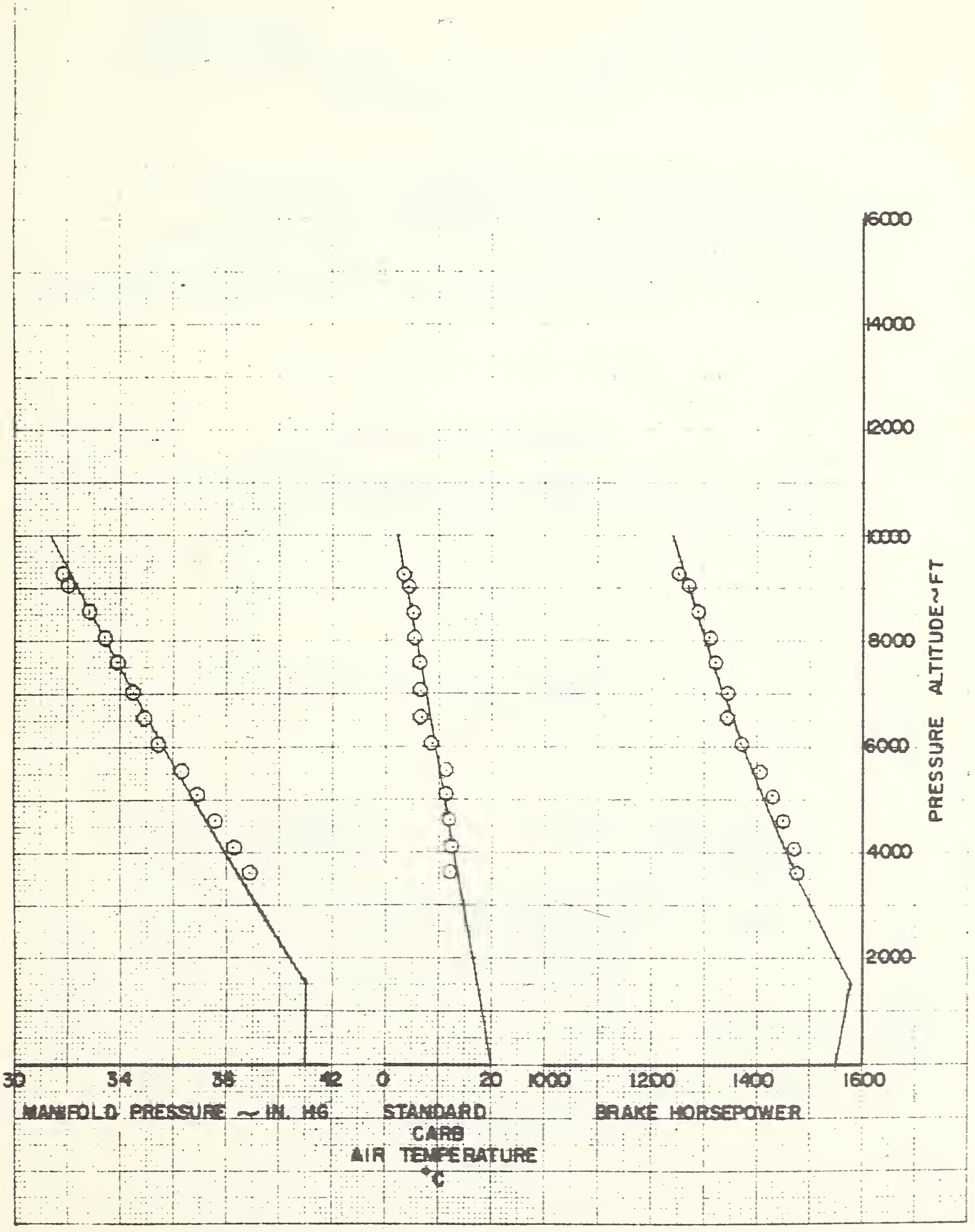


FIGURE NO.5

DROP SUMMARY

TB-25N s/n 10564

CONFIG: 15° FLAPS
WT. OF WATER: 8.34 LB/GAL.
WT. OF BORATE: 9.4 LB/GAL.
LOAD DISTRIBUTION: 300 GAL. FWD. TANK SECTION
300 GAL. AFT. TANK SECTION

ALTITUDE: 7500 FT
POWER FOR LEVEL
FLIGHT AT 2400 RPM

SYMBOLS

- – –△ 300 GALLONS OF WATER WAS DROPPED FROM THE AFT SECTION WITH THE FRONT TANK SECTION FILLED WITH 300 GALLONS OF WATER
- ——□ 300 GALLONS OF WATER WAS DROPPED FROM THE FWD SECTION WITH THE AFT TANK SECTION EMPTY
- ——◇ 300 GALLONS OF WATER WAS DROPPED FROM EACH TANK SECTION SIMULTANEOUSLY
- ◆ 300 GALLONS OF BORATE WAS DROPPED FROM EACH TANK SECTION SIMULTANEOUSLY

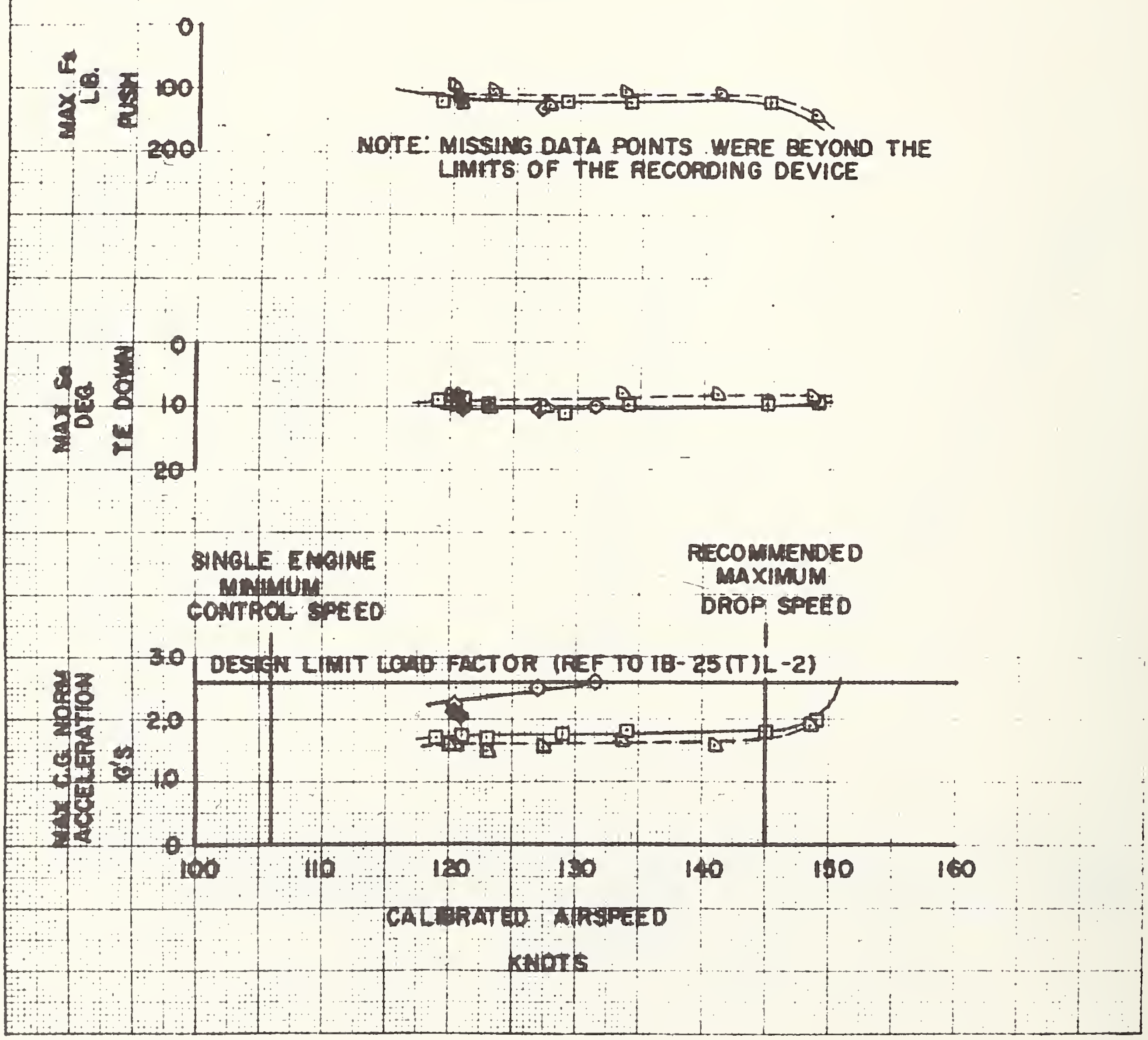


FIGURE NO.6

DROP SUMMARY

TB-25N s/n 10564

CONFIG: CLEAN
WT. OF WATER: 8.34 LB/GAL
WT. OF BORATE: 9.4 LB/GAL
LOAD DISTRIBUTION: 300 GAL. FWD. TANK SECTION
300 GAL. AFT. TANK SECTION

ALTITUDE: 7500 FT.
POWER FOR LEVEL
FLIGHT AT 2400 RPM

SYMBOL

- -○- 300 GALLONS OF WATER WAS DROPPED FROM THE AFT SECTION WITH THE FRONT TANK SECTION FILLED WITH 300 GALLONS OF WATER.
- —△— 300 GALLONS OF WATER WAS DROPPED FROM THE FWD. SECTION WITH THE AFT. TANK SECTION EMPTY.

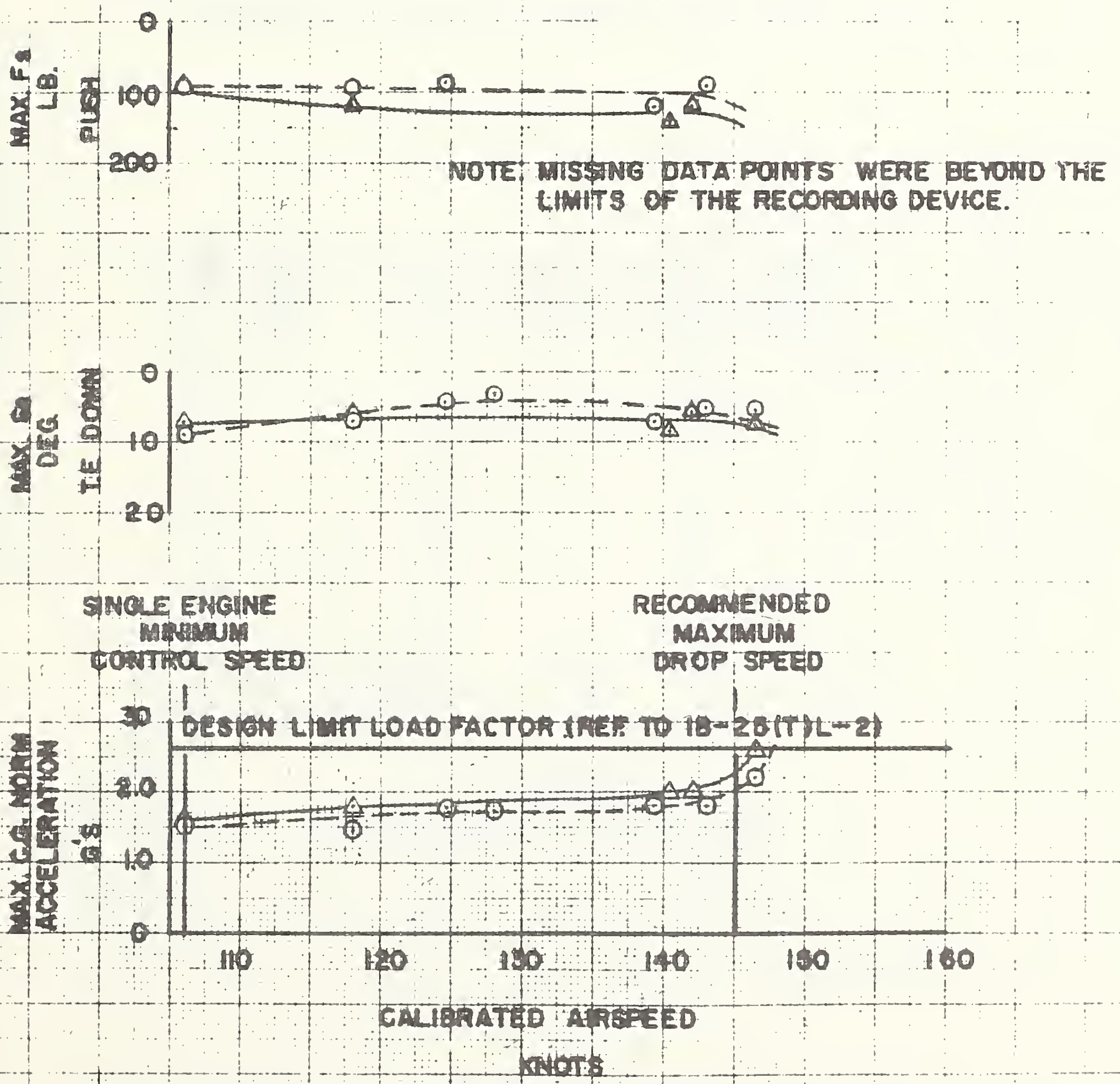


FIGURE NO. 7

DROP CONFIGURATION SUMMARY
TB-25N s/n 10564

CAS: 125 KNOTS
WT. OF WATER: 8.34 LB/GAL.
LOAD DISTRIBUTION: 200 GAL FWD. TANK SECTION
200 GAL. AFT. TANK SECTION

ALTITUDE: 7500 FT.
POWER FOR LEVEL
FLIGHT AT 2400 RPM

SYMBOL
○ 400 GAL. WATER TOTAL

NOTE: ENTIRE LOAD OF WATER DROPPED SIMULTANEOUSLY

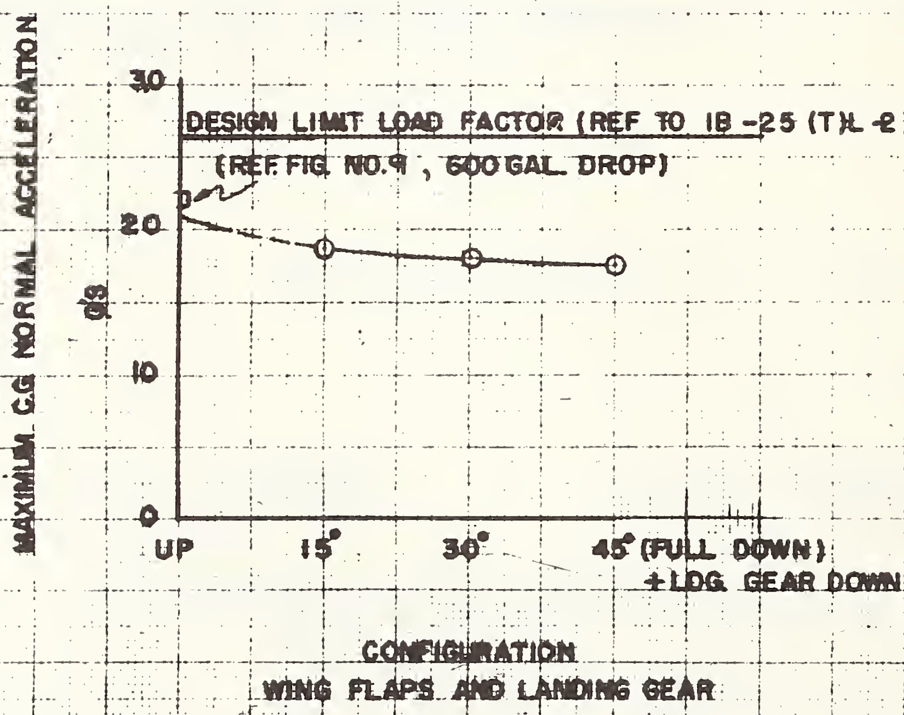


FIGURE NO. 8

WEIGHT OF RETARDANT DROPPED VS.
MAXIMUM C.G. NORMAL ACCELERATION
TB-25N s/n 10564

CAS: 124 KNOTS
CONFIG. 15° FLAPS
WT. OF WATER: 8.34 LB/GAL
WT. OF BORATE: 9.4 LB/GAL
LOAD DISTRIBUTION: ONE HALF LOAD IN FWD. TANK SECTION
ONE HALF LOAD IN AFT. TANK SECTION

ALTITUDE: 7500 FT
POWER FOR LEVEL FLIGHT
AT 2400 RPM

SYMBOLS
○ WATER
□ BORATE

NOTE: ENTIRE LOAD DROPPED SIMULTANEOUSLY

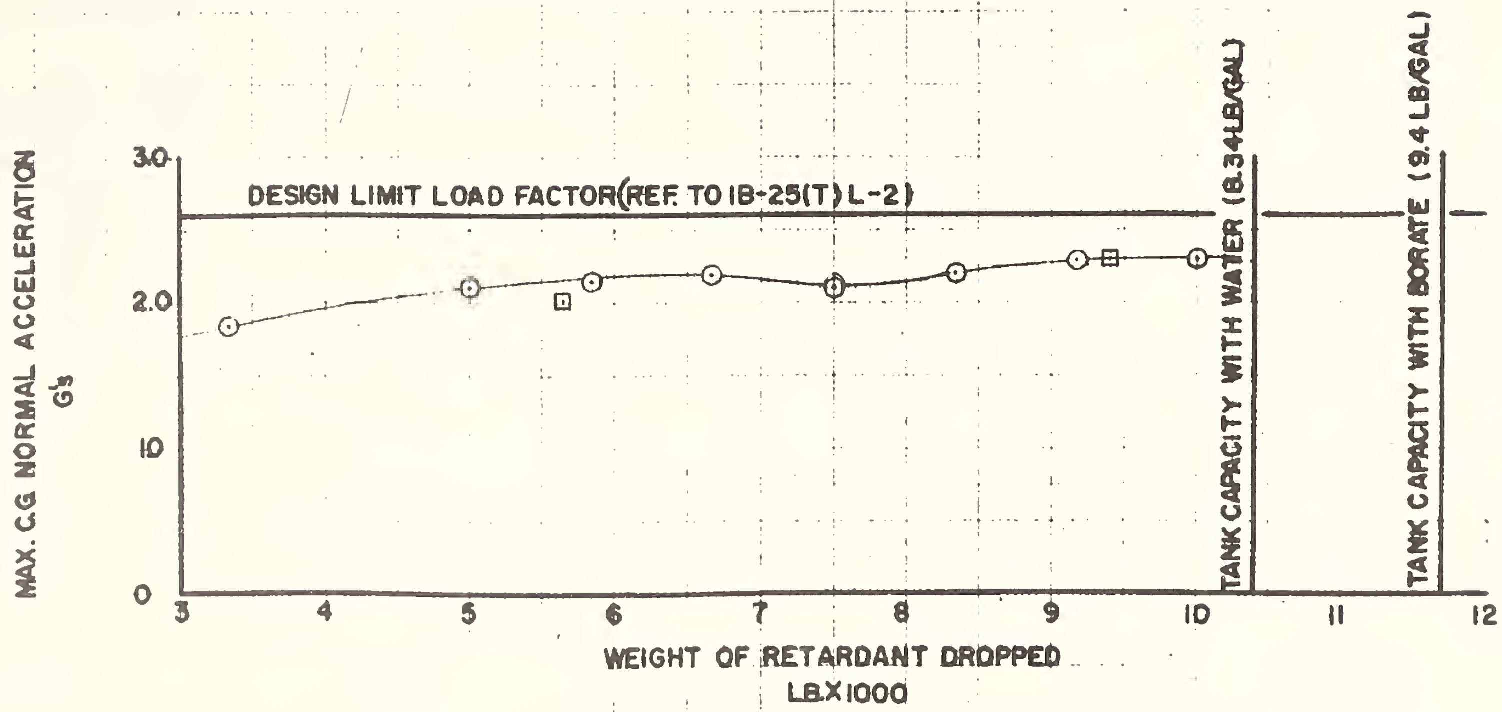


FIGURE NO. 9

DROP TIME HISTORY

TB-25 N S/n 10564

NORMAL DROP

WATER QUANTITY: 600 gal. total

CONFIGURATION: 15° flaps

GROSS WT: 29300 lb.(PRE-DROP)

C.G. POSITION: 243 in.(PRE-DROP)

CAS: 121 knots

PRES. ALT: 2300 feet

ALT. ABOVE TERRAIN: 75 feet

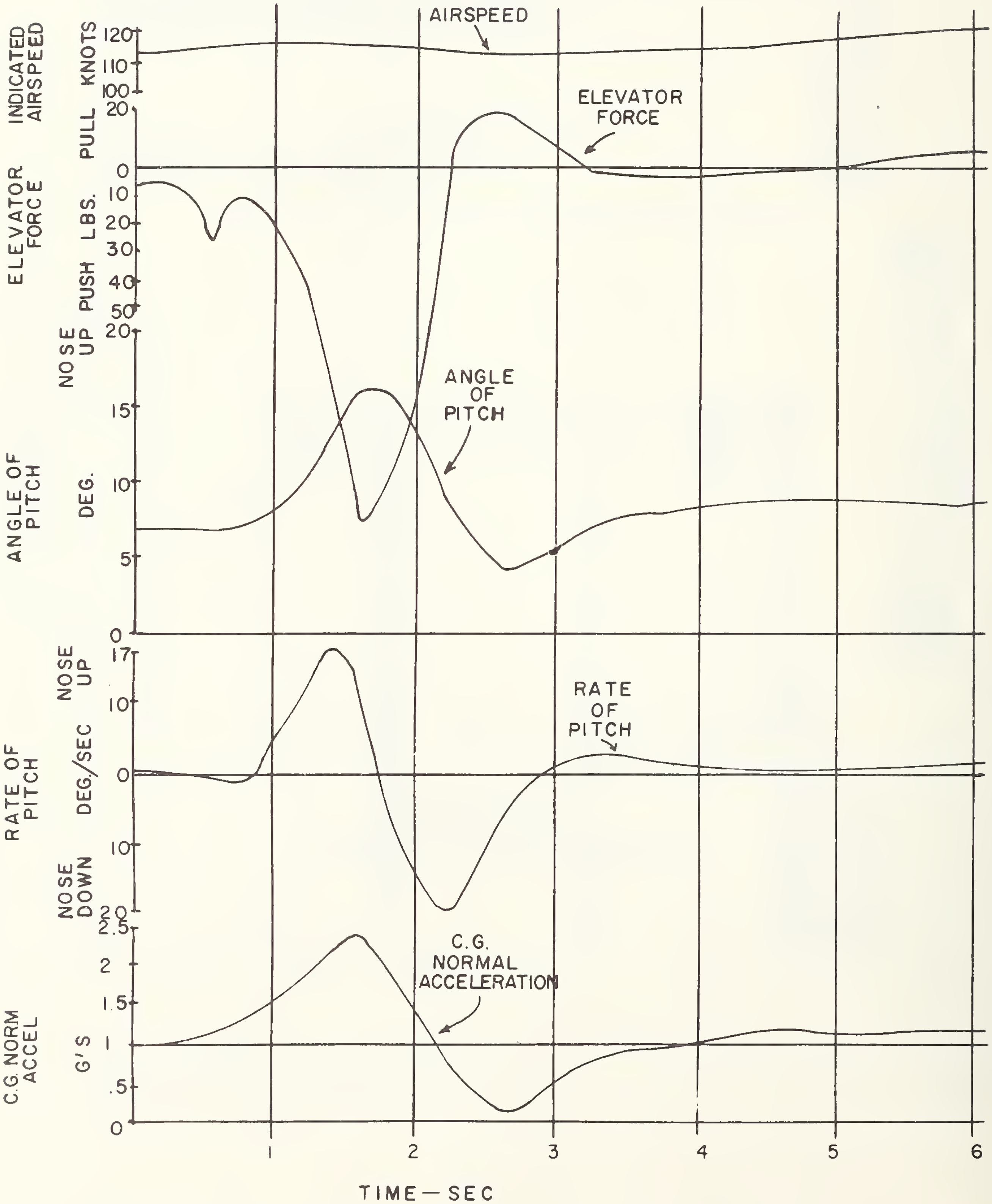


FIGURE NO. 10

DROP TIME HISTORY
TB-25N S/n 10564

1000 gal. BORATE

CONFIGURATION: 15° FLAPS
GROSS WT.: 32000 lbs.(PRE-DROP)

C.G. POSITION: 246 in.(PRE-DROP)
CAS: 124 knots
PRES. ALT: 7500 ft.

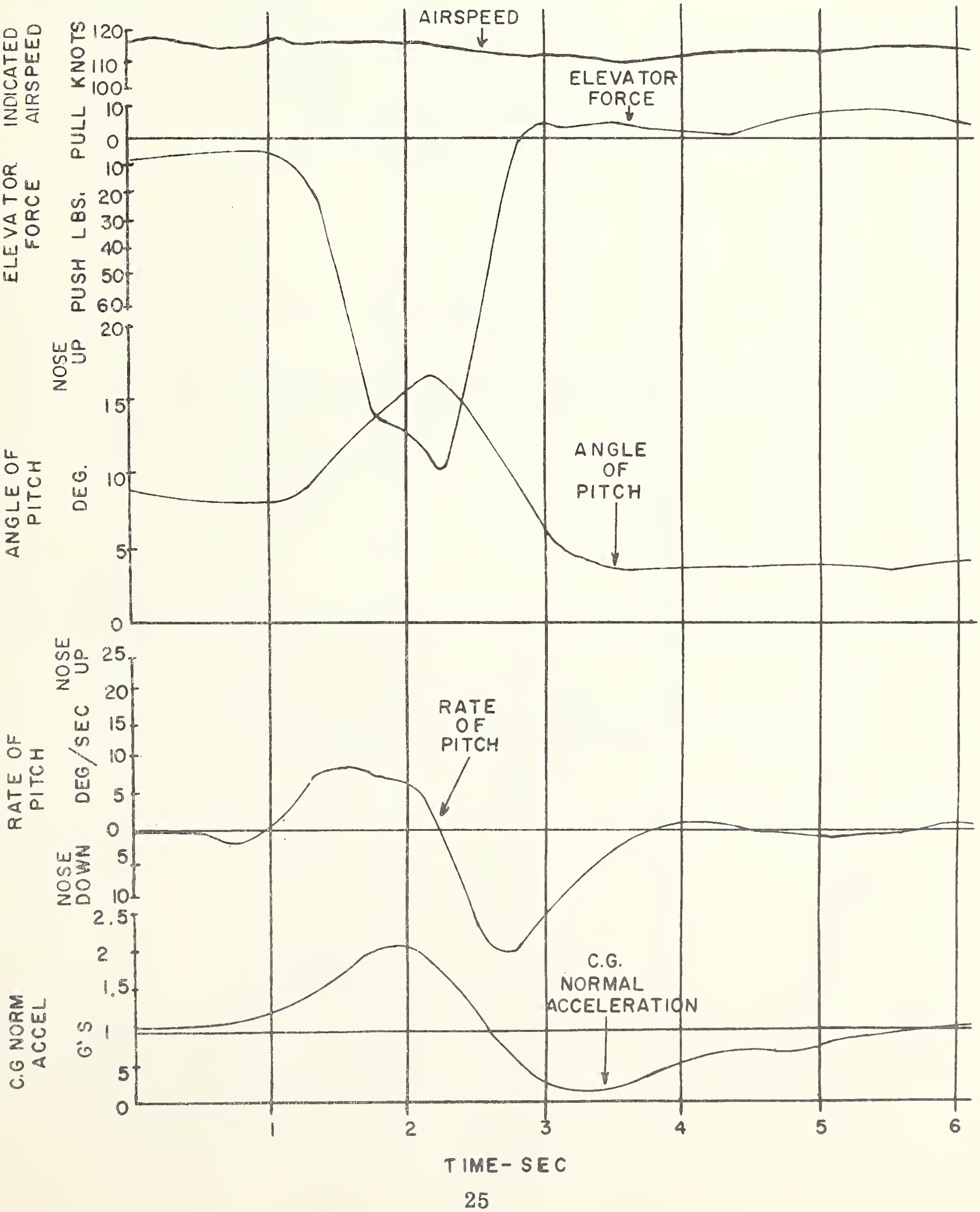


FIGURE NO. 11

DROP TIME HISTORY

TB-25N S/n 10564

STICK FIXED

WATER QUANTITY: 400 gal. total

CONFIGURATION: 15° flaps

GROSS WT: 27600 lb. (PRE-DROP)

C.G. POSITION: 243 in. (PRE-DROP)

CAS: 117 knots

PRES. ALT.: 7500 ft.

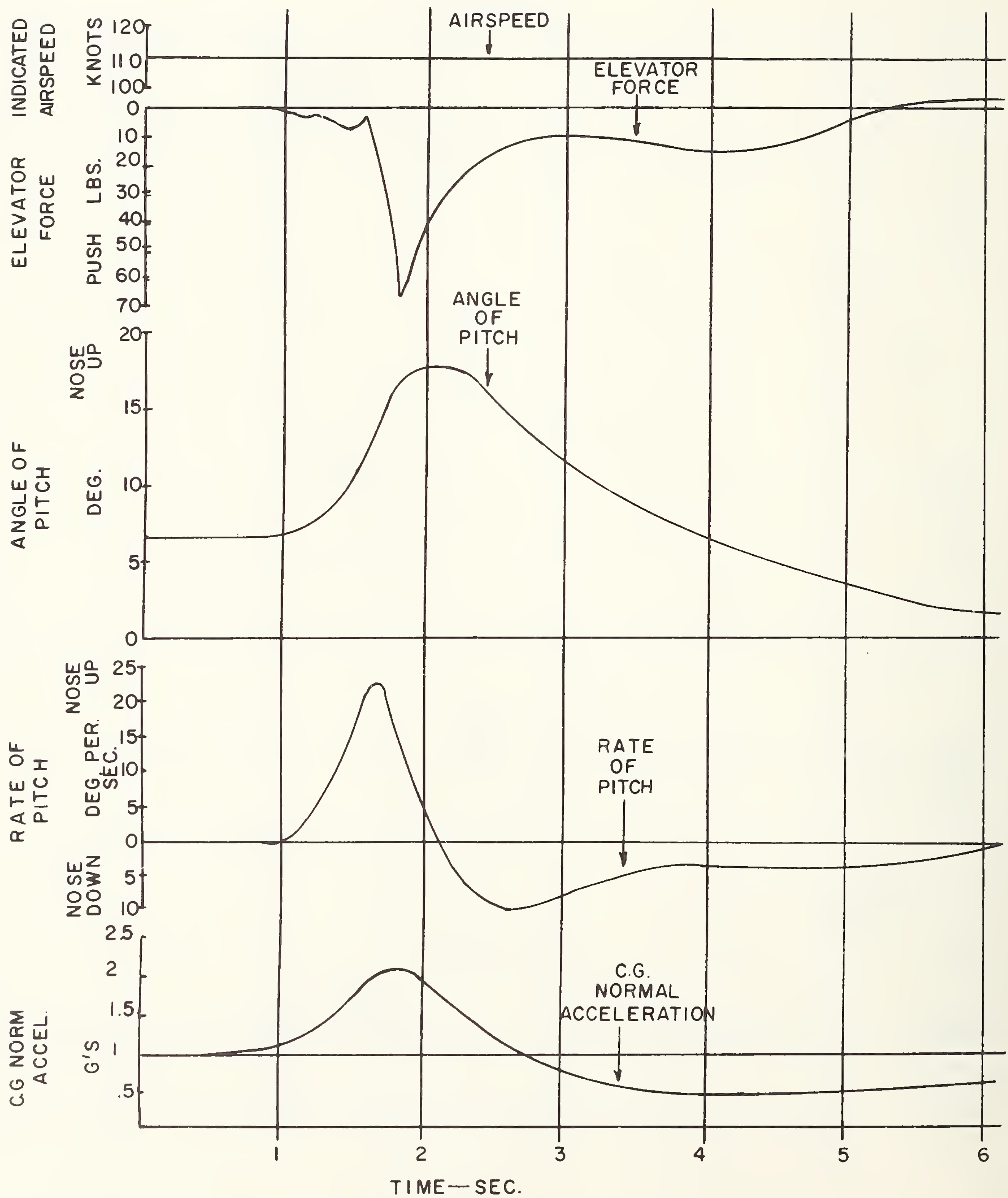


FIGURE NO.12

RETARDANT LOAD RELEASE TIME SURVEY
TB-25N s/n 10564

CAS: 125 KNOTS
CONFIG: 15° FLAPS
WT. OF WATER: 8.34 LB/GAL.
WT. OF BORATE: 9.4 LB/GAL
LOAD DISTRIBUTION: ONE HALF LOAD FWD TANK SECTION
ONE HALF LOAD AFT TANK SECTION

ALTITUDE: 7500 FT.
POWER FOR LEVEL
FLIGHT AT 2400 RPM

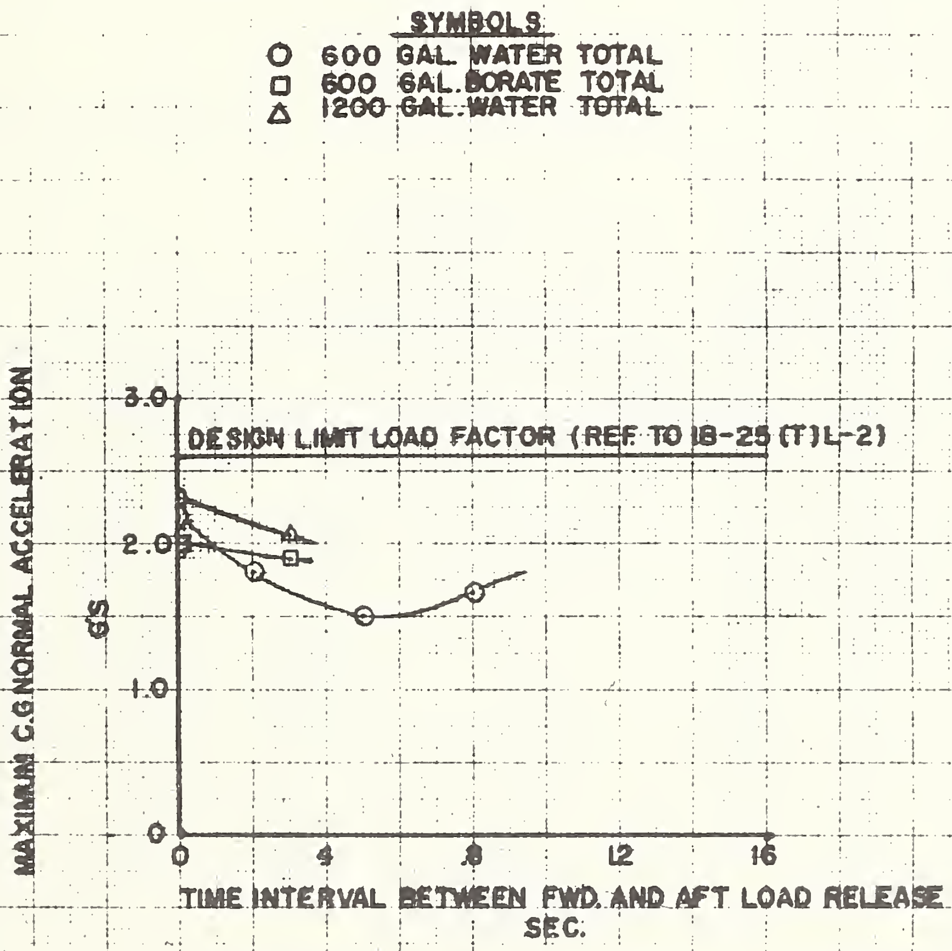


FIGURE NO. 13

DROP TIME HISTORY

TB-25N S/n 10564

.5 SEC. TIME DELAY BETWEEN TANKS

WATER QUANTITY: 600 gal. total (300 EA.) C.G. POSITION: 243 in. (PRE-DROP)

CONFIGURATION: 15° flaps CAS: 117 knots

GROSS WT: 29400 lb. (PRE-DROP) PRES. ALT: 7500 ft.

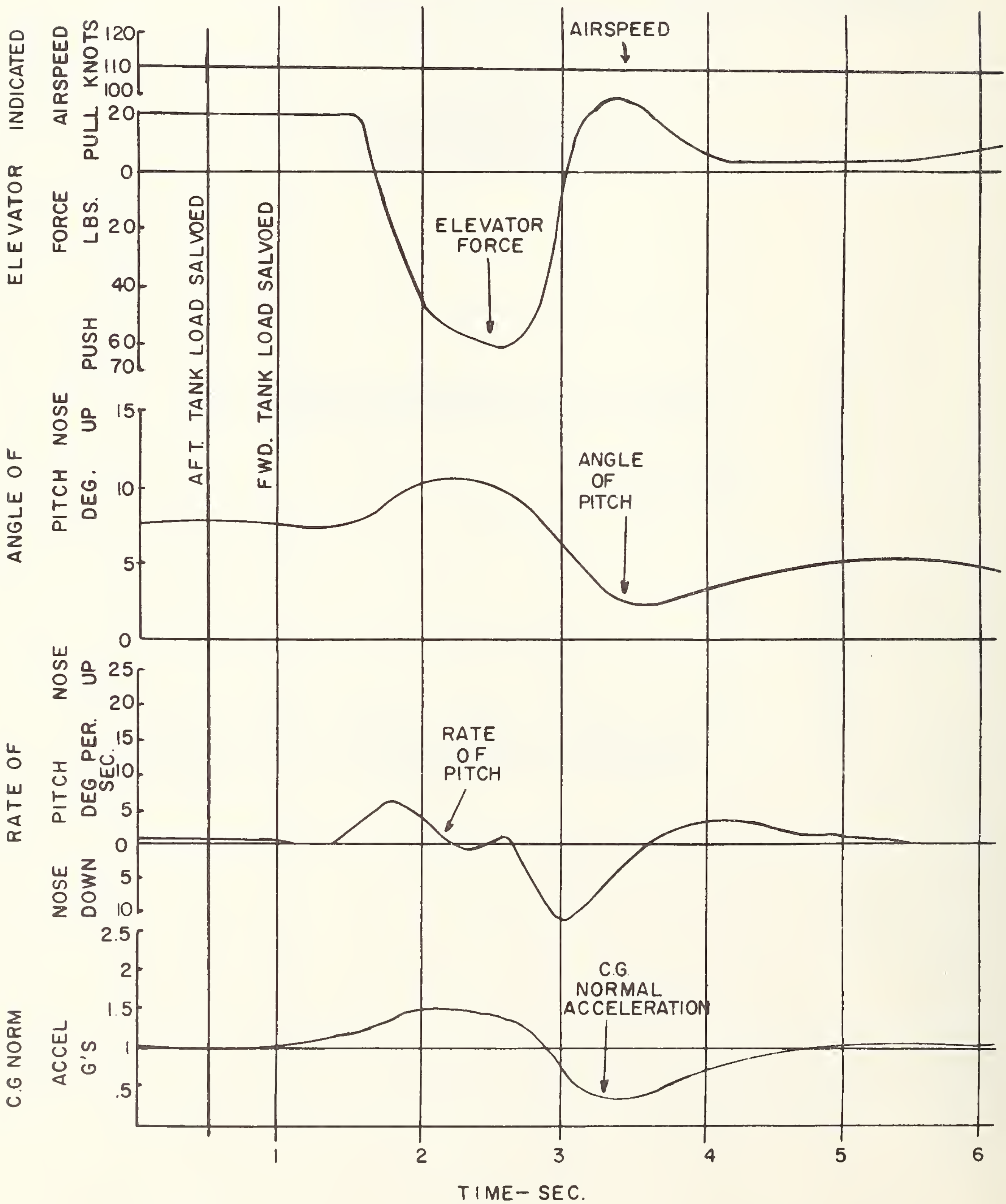


FIGURE NO. 14

STATIC LONGITUDINAL STABILITY SUMMARY

TB-25N s/n 10564

POWER FOR LEVEL FLIGHT AT 2400 RPM

SYMBOLS

○ C_L = 0.7 CLEAN

△ C_L = 0.7 15° FLAPS

□ C_L = 0.7 15° FLAPS + LANDING GEAR DOWN

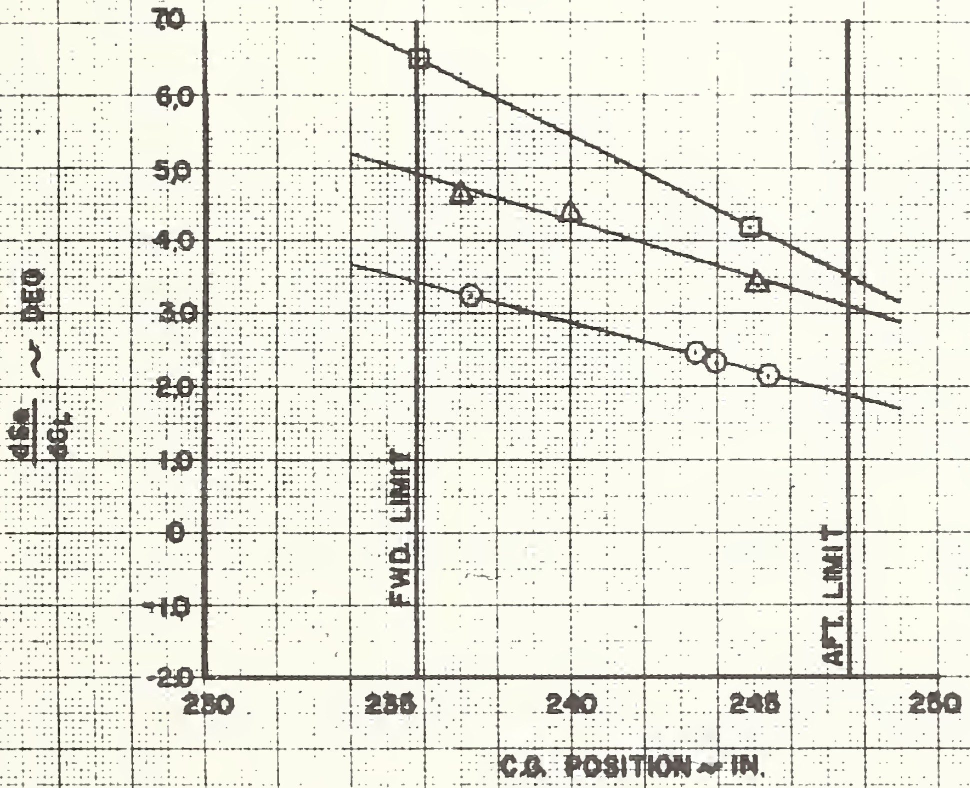


FIGURE NO. 15

STATIC LATERAL-DIRECTION STABILITY SUMMARY

TB-25N s/n 10564

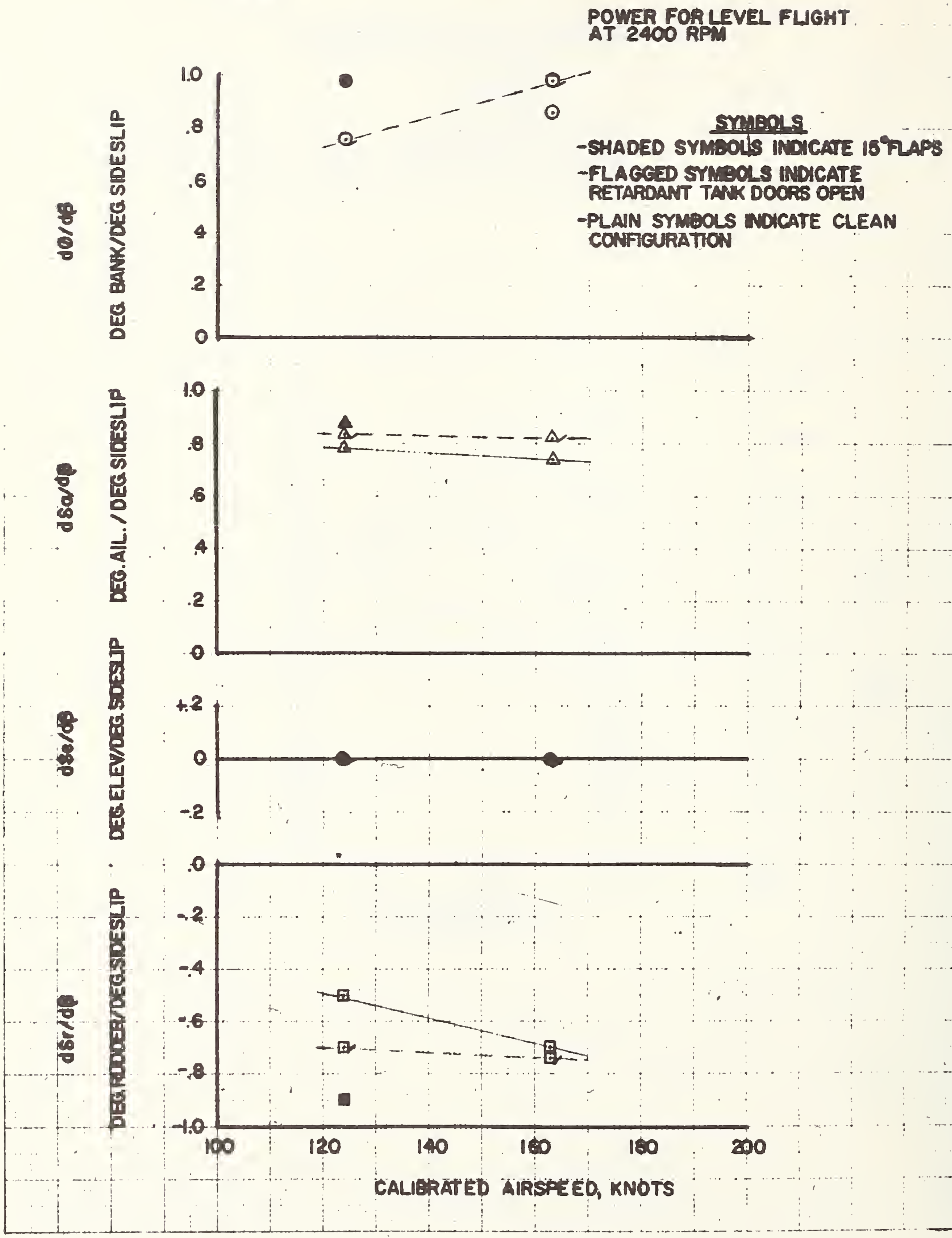


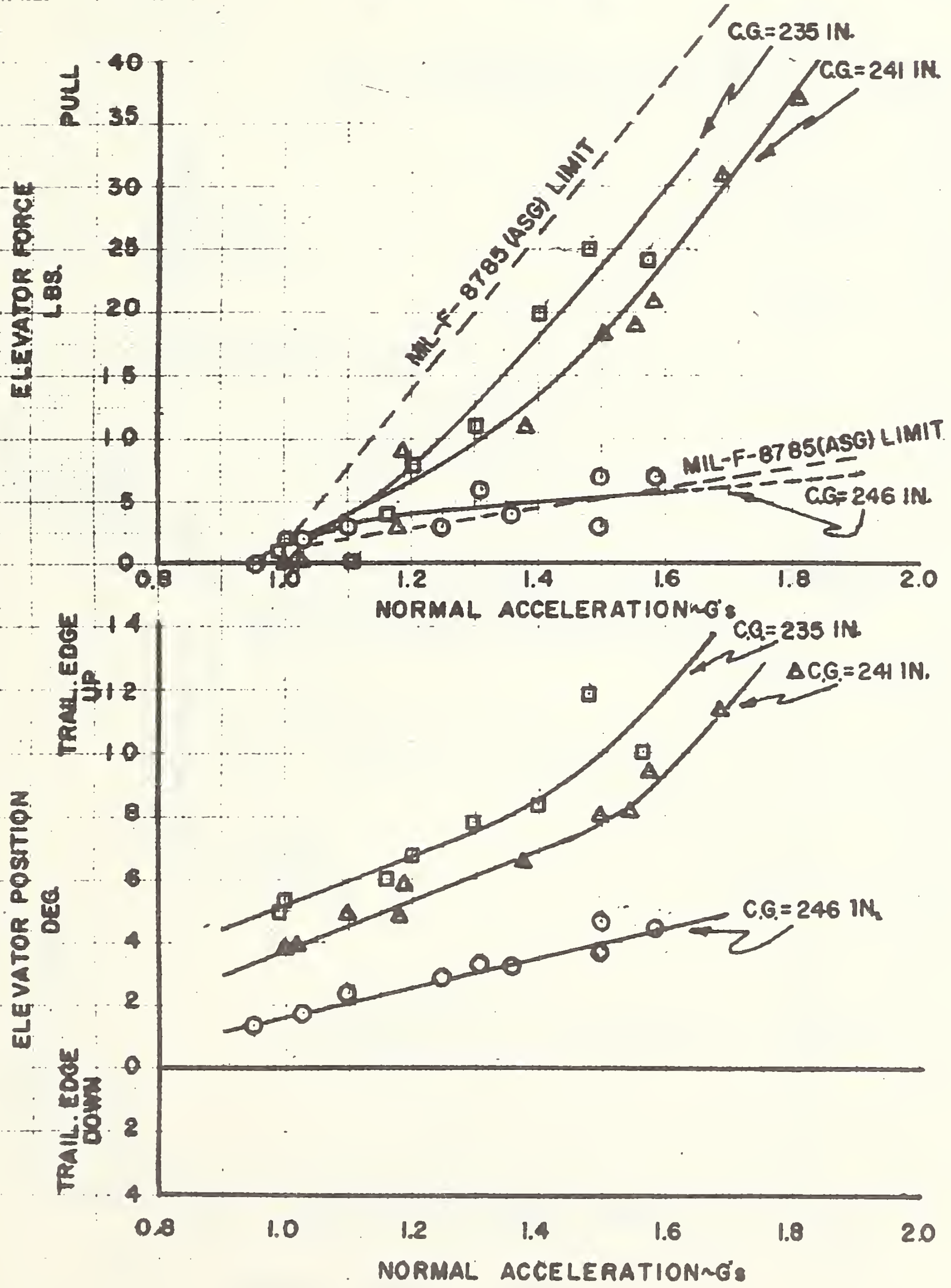
FIGURE NO.16

MANEUVERING FLIGHT CHARACTERISTICS

TB-25N S/N 10564

CRUISE CONFIGURATION

SYMBOL	C.G POSITION IN.	GROSS WT-LB	CAS KNOTS	ALTITUDE FT.
□	235	24600	126	7500
Δ	241	24500	126	7500
O	246	24900	126	7500



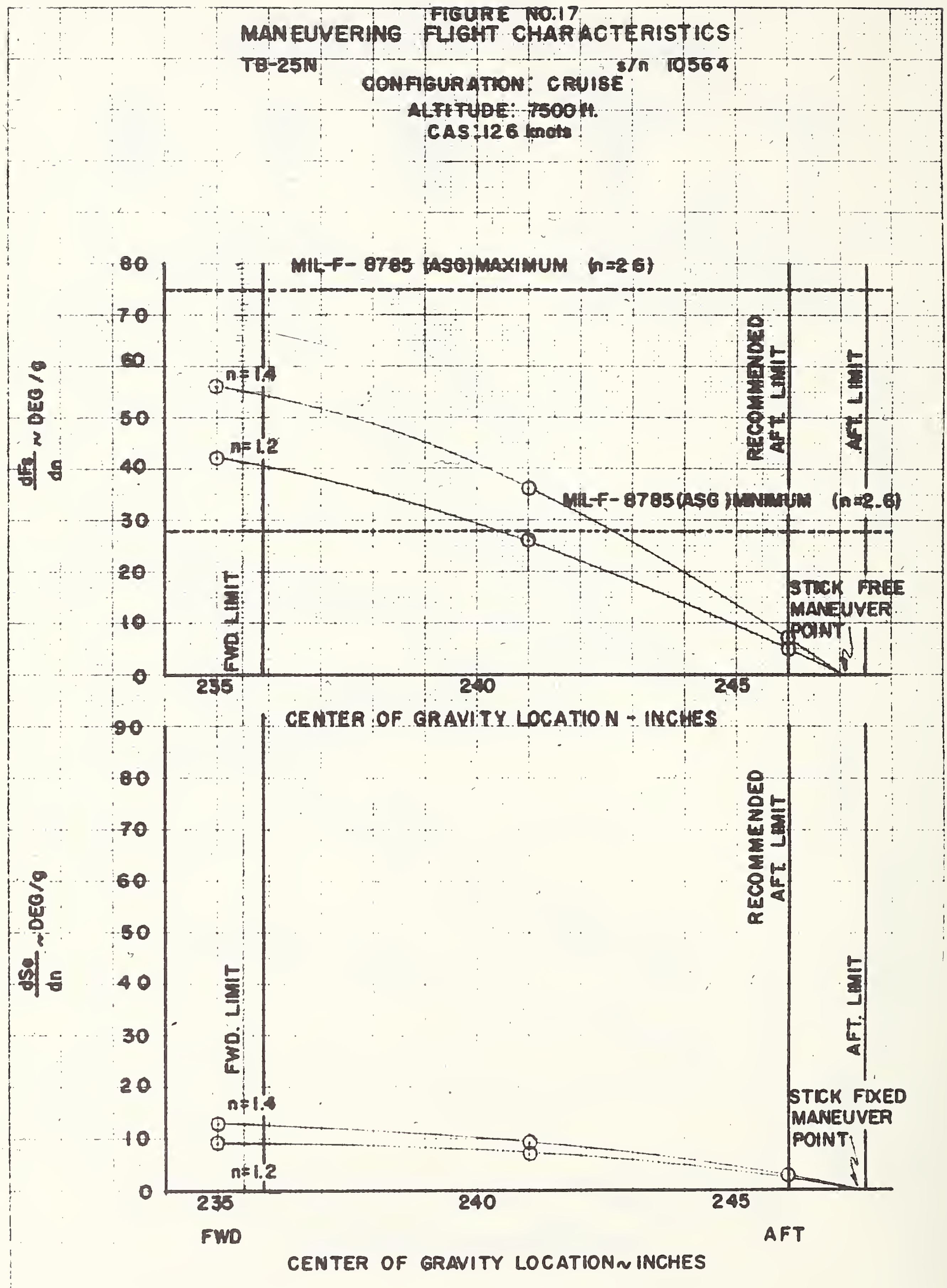


FIGURE NO.17
MANEUVERING FLIGHT CHARACTERISTICS
TB-25N
s/n 10564
CONFIGURATION: CRUISE
ALTITUDE: 7500 ft.
CAS: 126 knots
MIL-F-8785 (ASG) MAXIMUM (n=2.6)
MIL-F-8785 (ASG) MINIMUM (n=2.6)
n=1.4
n=1.2
FWD LIMIT
RECOMMENDED AFT. LIMIT
AFT. LIMIT
STICK FREE MANEUVER POINT
dFs/dn ~ DEG/g
CENTER OF GRAVITY LOCATION ~ INCHES
STICK FIXED MANEUVER POINT
dSe/dn ~ DEG/g
FWD
AFT
CENTER OF GRAVITY LOCATION ~ INCHES

FIGURE NO. 18
AIRSPEED CALIBRATION